PHYSICAL SCIENCE DSHS

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Balancing Chemical Equations

Why do we need to balance a chemical equation?

The law of conservation of energy: Energy cannot be created nor destroyed but only transformed from one form to another. This means that if you begin your reaction with hydrogen, the hydrogen will not magically transform to Oxygen. Elements do not mysteriously appear or disappear during a reaction; however, they rearrange to form new chemical substances. For instance, if you make a fruit salad and used an apple and a banana, although the fruit is chopped up, when you eat the fruit salad, you will still taste and see the apples and bananas. However, if you placed the cut apples and bananas in the blender, it would still be the same fruit ingredients (bananas and apples) but in a different state (liquid) and harder to visually distinguish from the physical change.

An accurate chemical equation has the correct ratio of reactants and products called Coefficients. These are the numbers in front of the reactant or product. For instance, in the fruit salad analogy if two apples were used with one banana one fruit salad would form. Let A represent the apples B for banana and A_2B for fruit salad the balanced chemical equation would be: $2A + B \rightarrow A_2B$.

It is also important to denote the state of the reactants and products in an accurate balanced chemical equation. The three states are solid (s), liquid (l), and gas (g). Because water is abundant we only let water have the state (l). Everything that is dissolved in water has (aq) which means aqueous like aqua.

When we successfully balance a chemical equation you may calculate the amounts of each reactant and product using Stoichiometry.

Let's practice balancing chemical equations

Example 1: Decomposition of water.

$$H_2O_{(g)} \rightarrow H_{2(g)} + O_{2(g)}$$

Step 1: Draw a line down from the arrow separating the reactants (left side) and products (right side) of the equation.

$H_2O_{(g)} \rightarrow H_{2(g)} + O_{2(g)}$

H	O	H	O

Step 2: To the left of the arrow make a column of all the elements present

Step 3: Now calculate the number of atoms of each element on the reactants and products side

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$H_2O_{(g)} \rightarrow H_{2(g)} + O_{2(g)}$

H	O	H	O

Step 4: Evaluate the unequal amounts of elements to follow with the law of the conservation of energy.

We can see there are unequal amounts of oxygen in the water on the reactants side of the equation. We need 2 oxygen so we must put a 2 in front of the water molecule. This number represents the coefficient. The coefficient is the amount of water molecules needed for this reaction. Since the coefficient is two we have two water molecules.

$2H_2O_{(g)} \rightarrow H_{2(g)} + O_{2(g)}$

H	O	H	O

Step 5: Recalculating the numbers on the products and reactants side of the equation.

$2H_2O_{(g)} \rightarrow H_{2(g)} + O_{2(g)}$

H	O	H	O

Because we put the coefficient 2 in front of the water we now have unequal amounts of hydrogen in the products side, there is a 4 to 2 ratio so we must put another 2 coefficient in front of the hydrogen gas.

There are two factors involved in balancing: the first is the coefficient, which is how many molecules or compounds in each product or reactant. The second is the ratio of atoms in a compound or molecule that comprises the molecule or compound. For instance H_2 has 2 hydrogen atoms to make one hydrogen molecule. The coefficient must be multiplied by the ratio of atoms in a molecule or compound to correctly add up all the elements present in a molecule or compound.

Step 6: Balancing the hydrogen by putting a 2 in front of the hydrogen gas molecule.

$2H_2O_{(g)} \rightarrow 2H_{2(g)} + O_{2(g)}$

H	O	H	O

All numbers are equal on both the reactants and products side so the chemical equation is now balanced.

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